CHICAGO ENGINEERING REVIEW

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7 P. M.—Hour of Opportunity!

(Read the Chief's New Year Message on Next Page)

Seven Oclock-1928

A New Year's Message from the Chief

AS the old year draws to a close, every man likes to stop and think over his plans and ambitions for the twelve months that lie ahead. Here is a brand-new year—as fresh and full of promise as an unread book. What does it hold? What can we make of it? Will the close of the coming year find us further along on the road to success than we are now?

To my mind, the biggest thing about the New Year—it's Leap Year, and that means 366 days instead of the usual 365—is that 366 times during 1928, it will be seven o'clock in the evening!

* * *

A famous character-builder, J. Franklin Wright, once said that the most important moment of a man's day is at 7 P. M. For then it is that he pushes back his chair and rises from the supper table, with the question before him, "What shall I do this evening?"

366 times during 1928, it will be seven o'clock for you.

And 366 times, the clock will tick off the minutes between 7 P. M. and bedtime—the golden minutes of opportunity.

What will YOU decide, at seven o'clock? You're going to do something—either pick up a book, or drift out with the gang, or drop in at a movie, or spend the time in another way, a wiser way—in training yourself for a better job!

* * *

I want you, during 1928, to ask yourself one thing, each time seven o'clock rolls around. Say to yourself: "How will what I am about to do tonight, look to me ten years from now? How is it going to affect my positiion in life, my income, my future? It may not do me any harm, but will it actually HELP me? Or will I, in 1938, have cause to regret this evening as a golden opportunity that I deliberately wasted?"

If you will do that, my ambitions and earnest students, you'll find that there's only one profitable decision for you to make, at seven o'clock. And that is, to dig in on those electrical lessons of yours with all your might and main!

And how well you are going to be repaid for the efforts you make in 1928! Everywhere, signs point to a growth and prosperity in Electricity unequaled in its 50 years of sensational progress. The depression in other lines of business for the last few months has only served to bring out the good fortune of men who are electrically trained. Today, while 10 unskilled laborers fight for every job, back-breaking and poorly paid though it may be—the electrician alone is "sitting pretty."

Make up your mind to cash in on every last one of the 366 "seven o'clocks" in 1928, and the New Year will be the "red letter year" of your life!

Here's wishing you—the Happiest New Year of All!

L. L. Cooke.

Putting the Vacuum *into Vacuum Tubes*

By R. C. ROBINSON
Engineer in Charge of Vacuum Tube Department of the General Electric Company

THE value of research is unquestionably proven by the worth of the various types of evacuated tubes or bulbs, which have been sold during the past few years. Experiments, in which some material attached to lead wires was sealed into glass vessels and the vessels exhausted, became of great commercial importance when Edison made his first incandescent lamps in 1879.

Edison's lamps took hours to exhaust while the present day marvel takes seconds. Originally slow acting mercury pumps were used for this work. These were replaced by Packard oil pumps, then by Gerycke oil pumps, later by rotary oil pumps, and finally by mercury condensation pumps of the Langmuir type. In order to improve the vacuum obtained with the pumps, they are assisted by different chemicals; in the earlier days by phosphorous in the presence of a glow discharge in the bulb, and later by numerous chemical compounds, known as "getters," such as various chlorides and fluorides, which when introduced into the bulb materially improve the performance of the lamp.

Present Lamp Far More Efficient

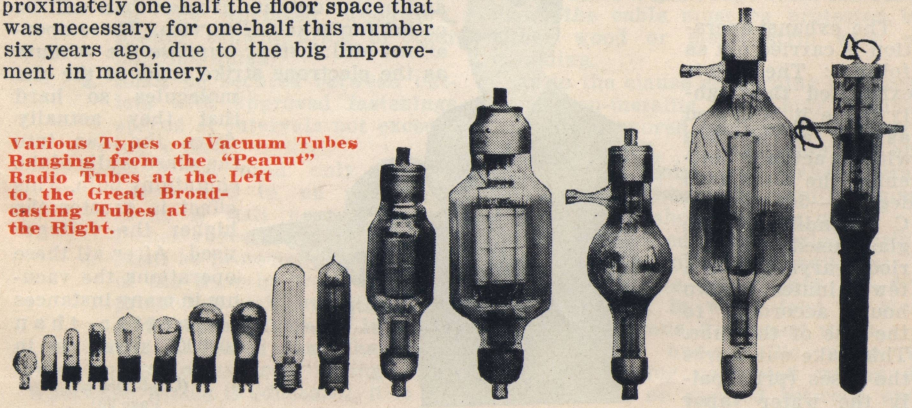
More than three hundred million vacuum lamps per year are made in approximately one half the floor space that was necessary for one-half this number six years ago, due to the big improvement in machinery.

The results of these extended researches and improvements have given us a lamp seven times as efficient as Edison's, and one of the few household necessities which has steadily decreased in price. Since 1921 their price has been decreased ten times, so that now they cost us only 49% of what they did in 1914.

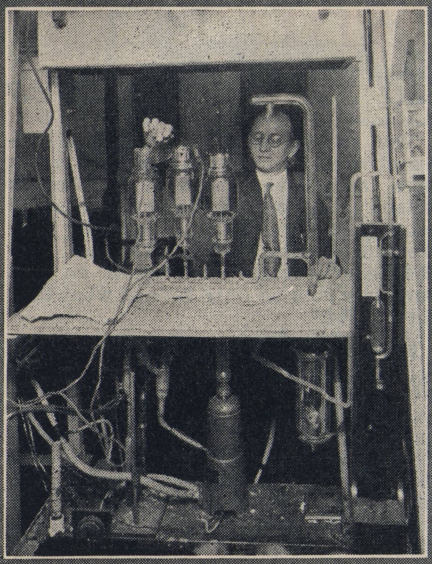
Many scientific men, such as Fleming, J. J. Thomson, Richardson, Langmuir, etc., have studied the different phenomena observed in incandescent lamps. Langmuir's studies of the current flowing through the space in lamps proved that a hot body in a good vacuum gives off electric particles, electrons, the quantity depending on the temperature of the hot body and the material from which it is made.

Thorium in Radiotrons

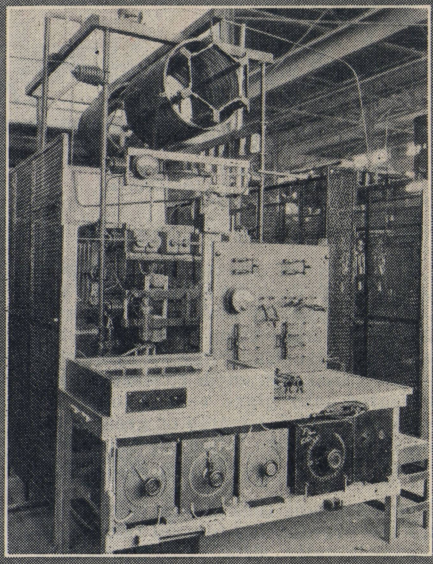
In the present day vacuum tubes three types of substances are used as the source of electrons; the oxides of certain metals, the pure metals themselves, and these pure metals mixed with a small amount of thoria. The oxides are coated on a wire like platinum or nickel and give off their electrons at temperatures below the melting points of these metals. The pure tungsten filaments are operated at about 2,400 degrees—2,500 degrees K, and those containing thoria around 2,000 degrees K. Operating at the same temperature, the emission from thorium is about five thousand times



Various Types of Vacuum Tubes Ranging from the "Peanut" Radio Tubes at the Left to the Great Broadcasting Tubes at the Right.



Removing Air from Tubes by the Langmuir Method.



Testing Equipment at General Electric Co. Laboratory for Testing New Tubes.

greater than from tungsten. A pure thorium filament, however, vaporizes and melts at too low a temperature to get sufficient emission from it to make a successful radiotron. It, however, evaporates much slower when in the form of a thin film on tungsten and so it is used in this condition. The popular type of receiving radiotron, UX-201-A, has such a filament, a tungsten base containing one or two percent of thoria. This thoria, at the operating temperature, slowly diffuses to the surface of the filament as thorium metal.

Bulbs Exhausted While Hot

The exhaust operation is carried out as follows: The bulb is exhausted thoroughly while it is heated as hot as possible without actually softening the glass (400 degrees—500 degrees C depending on the glass used) for periods varying from a few minutes to two hours according to the size of the tube. This bake out drives the gases (principally the water vapor and carbon dioxide) from the glass walls. Next the filaments are burned at temperatures higher than they will be when in service. This removes the gases from the filament, leads and supporting anchors. Finally the anodes, grid structure or other parts must be brought to incandescence to expel their occluded gases. This may be done by heating them in a high frequency electric field, or by bombarding them with electrons from their own cathode.

Bulbs Must Be Aged Before Sold

Before the tubes can be sold they must be aged and operated at voltages and power outputs greater than will be called for in actual service. These operations still further improve the vacuum as the electrons strike some of the gas molecules so hard that they actually drive the gas into the glass walls of the containing bulb. This effect is greater the higher the voltages used. After all these operations the vacuum in many instances is better than .000001 m.m., or in

The Coolidge Tube, Latest Discovery for X-Ray Surgery.

(Continued on Page 23)

How to Install the New
Non-Metallic Cable

A SHORT time ago several manufacturers developed a new type of flexible cable for wiring old houses to take the place of metallic sheath or armored cable. It is more flexible than armored cable and has numerous other advantages as well as some disadvantages. It is made in two wire and three wire sizes, two wire cable being somewhat flat as shown and three wire cable being round. The wires have standard code ratings as to rubber and fabric, and have layers of re-inforced fabric as added protection which make it suitable to be installed without the use of porcelain supports. Here are some of the code rules for the installation of non-metallic cable.

(a) Cable shall not be used for circuits exceeding 300 volts between conductors.

(b) Shall be of approved types and of two and three conductor assembiles in sizes Nos. 14 to 6 inclusive.

(c) Cable shall not be used except for all circuits in residence occupancies and in out-buildings on the same premises where other types of wiring are not required by National Code.

This last rule means that such cables may be used for mains, sub-mains and branches in any residence provided such buildings are of frame or semi-frame construction having wood joist, wood stud or wood furred partitions, floors and walls.

(d) May be used in exposed wiring under the following conditions:

1. Shall be mounted directly upon the surfaces woodwork, plaster, cement, brick, or other building finish.
2. Shall be secured between outlets with approved fastenings spaced at intervals not exceeding 4 feet.
3. Shall be used only in dry places and in no place run along a wall nearer than 6 inches above the floor.
4. Shall be protected within 5 feet of the floor by wood or metal protecting strip over the cable and securely fastened in place.

It should be noted that the above rules apply to exposed wiring only. Where the wiring is concealed, it is not necessary to run it on the surface of the material mentioned. Instead, it may be run through holes in joists, studs, etc., as shown in Fig. 2, p. 7.

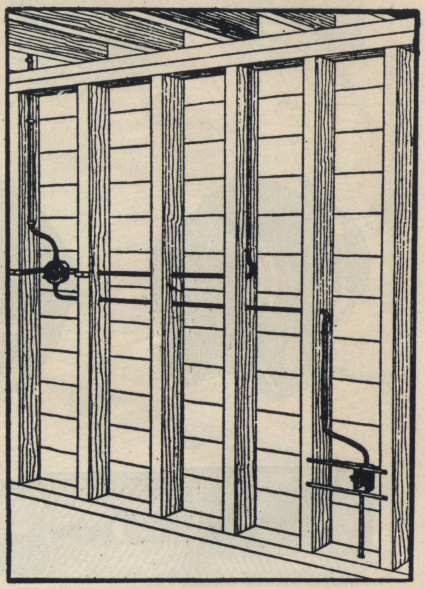


Fig. 1—Loop System of Wiring with Non-Metallic Cable

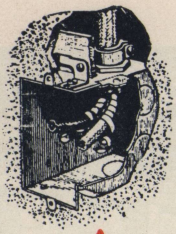
In an old dwelling, it may be very convenient to run this cable along the mop boards but it must be borne in mind that the cable should be at least six inches above the floor.

In making a vertical run from the floor upward as is the case when making a run to a gas range from the basement, the cable must be protected by either wood or metal strip such as moulding.

As to the clause concerning dry locations, non-metallic cable may be used wherever armored cable of the ordinary type is allowed. In basements that are exceedingly moist and where lead sheathed cable would be required, non-metallic cable should not be used.

(e) May be used in concealed wiring under the following conditions:

1. Shall be used only in dry places, in wood joist or stud partitions, floors and walls.
2. When non-metallic cable is used for concealed wiring, it shall be secured between out-



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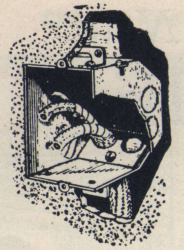

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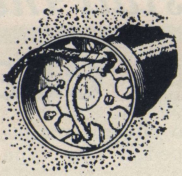

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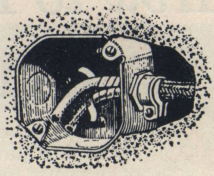

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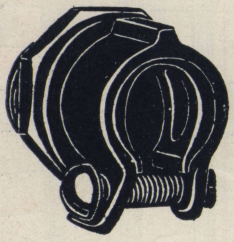

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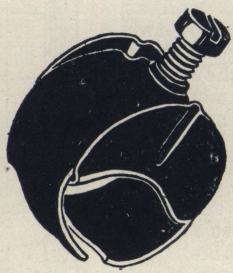

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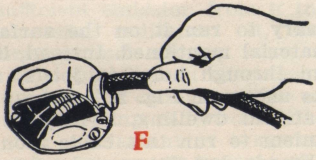

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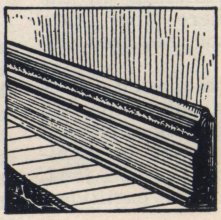

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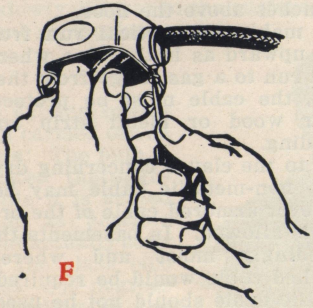

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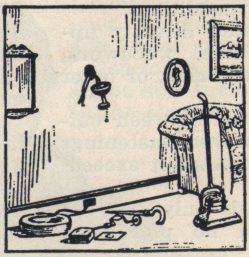

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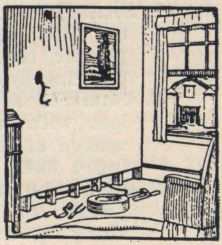


K

"A" Methods of Bringing Non-Metallic Cable Into Boxes and Plates.

"B" Box Connectors for 2 Wire Cables.

"C" Adaptable Box Connectors for Either Two-Wire or Three-Wire Cables.

"D" Assembly of Two-Wire Cable.

"E" 2-Wire and 3-Wire Cable Supports.

"F" Installing Two-Wire Cable in an Ordinary Outlet Box.

"G" Cable Run Along Baseboard.

"H" Section Views, 2 and 3-Wire Cable.

"J" How Cable May Be Run to an Extra Plug Below a Wall Outlet.

"K" Cable Run Behind Baseboard.

lets by approved fastenings spaced at intervals not exceeding 4 ft. or by other practicable means which will provide for the entire installation being securely fastened in place.

3. Where it is impracticable in concealing wiring to provide the supports specified in the preceding paragraph, runs of non-metallic sheath cable may be fished between outlet boxes or plates.

The last clause is very important to the wireman for it is this fishing between the walls which gives this form of wiring its advantages over the older method of knob and tube or cleat wiring.

(f) Shall be run without joints, splices or taps from outlet box to outlet box or junction boxes or plates.

The reason for this rule is obvious and is the same as the roll applied to armored cable. Fig. 1 shows the so-called "Loop System" without splices.

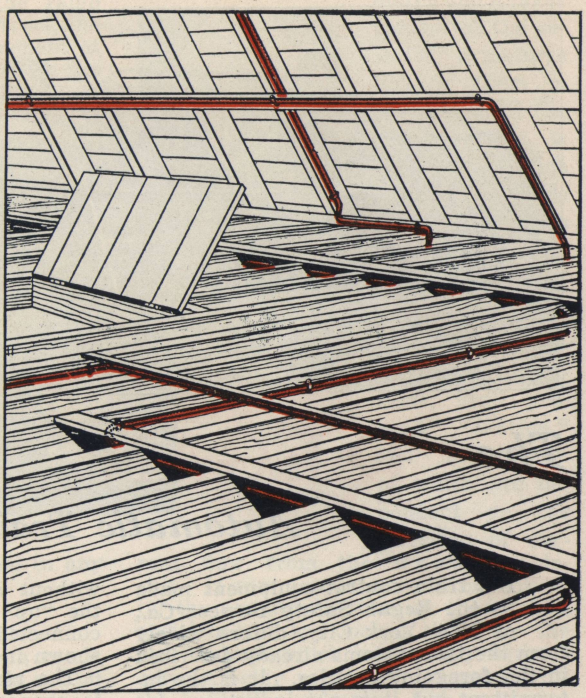


Figure 2—Various Methods of Running Cable in Exposed Wiring

Must Be Rigidly Fastened

(g) Shall be provided with approved outlet or junction boxes or plates at each outlet into which the cable shall be run and to which it shall be rigidly fastened by means of approved fittings which completely close the opening. If cable enters boxes from the side in concealed work, boxes of 1½ inch depth are required. It is recommended that for all side wall and partition outlets in concealed work in buildings under construction outlet boxes having a depth of approximately 1½ inches be used.

Some of the fittings used to comply with the above requirements are shown on page 6.

(h) All bends shall be so made and other handling shall be such that the non-metallic covering will not be injured.

(i) Shall not be buried in plaster, cement of similar finish.

(j) When non-metallic sheathed cable is installed in conduit the provisions of section 503 of this article shall apply as far as practicable.

(k) When in exposed or in concealed wiring, non-metallic sheathed cable is run through holes in studs, joists or similar wood members, the holes shall be located at the approximate center of the studs and not less than two inches from the nearest edge of joists or other members whose depth permits this spacing.

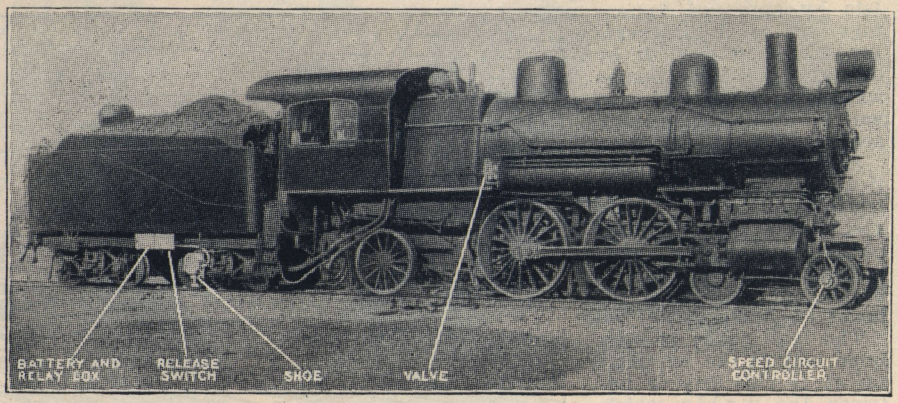
There is nothing difficult or mysterious in the above rules unless it is the one which refers to running cables in conduit which is not likely. If it is so used cable is to be treated as ordinary wire.

Exposed Cable Must Be Protected

1. In attics and roof spaces where within 5 ft. above the floor or joists, the cable shall be considered as exposed to mechanical injury and shall be protected by suitable wood or metal strips securely fastened in place. Cable shall not be used across the top of joists in unfinished attics or roof spaces nor in similar locations.

The method of running wires in an attic is shown in Fig. 2. The cable may be run through holes in joists with a protecting strip of wood run above

(Continued on page 14)



Locomotive Equipment, Regan Automatic Train Control System, Rock Island Ry.

The REGAN
Automatic Train Control System

THE train control equipment made by the Regan Safety Devices Co., of New York City, differs widely from the two systems already described in the foregoing articles. It is the intermittent but it is not inductive. Instead it depends on physical contact with a ramp along the wayside.

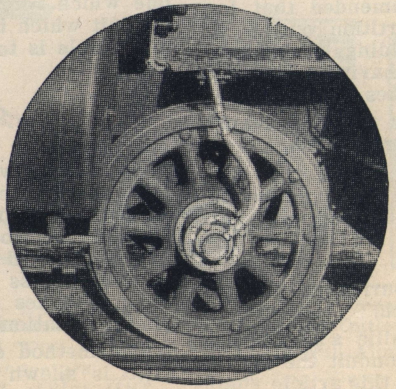
The locomotive and tender equipment is so arranged that it is connected to the wayside circuit when passing over a ramp. As it rides up the surface of the ramp it disconnects the storage battery, at the same time connecting the indication relay to the ramp circuit. As the shoe slides down the incline at the other end of the ramp, the storage battery is connected to the control equipment.

Shoe Held Down by Air Pressure

The shoe is held in a downward position by air pressure which also insures positive contact with the ramp. A bolt lock is provided for fastening the shoe in the "up" position in case it becomes necessary to run the locomotive without automatic control. When in the "up" position, the battery is disconnected. These two positions are shown in the picture on page 9.

The reservoir and the brake magnet is connected directly in the reservoir supply line. When the magnet is energized, the brake pipe vent is closed. When the magnet becomes de-energized the brakes are automatically applied and cannot be released by the engineman.

The wayside apparatus consists of a ramp 80 feet long, such as you see illustrated on page 10, a battery, a relay and the necessary wiring connecting the ramp with the signal system. It is built up of angle iron with a copper insert and is mounted on cast iron supports fastened to the ties. The battery of 16 cells provides current.



Speed Circuit Controller Attached to Front Wheel of Locomotive

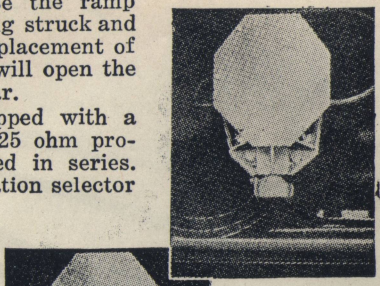
Displaced Ramp Gives "Stop" Indication

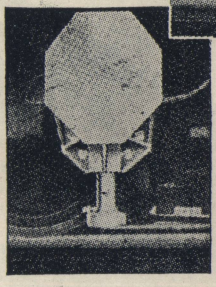
The ramp displacement detector shown in the connecting diagram is for the purpose of giving a re-

strictive indication in case the ramp should be displaced by being struck and moved out of place. A displacement of 5/8ths of an inch or more will open the circuit to the signal in rear.

The locomotive is equipped with a 10 volt battery having a 25 ohm protective resistance connected in series. It does not serve the indication selector which receives current instead from the wayside battery through the ramp and shoe and the rails.

The clutch is normally energized but its circuit is broken through the four contacts on the shoe when it is raised by passing over the ramp. These contacts are bridged by two sliding knives fastened to the shoe stem but insulated from it. A fifth contact on the shoe connects to the indication selector but is not disconnected in any way.





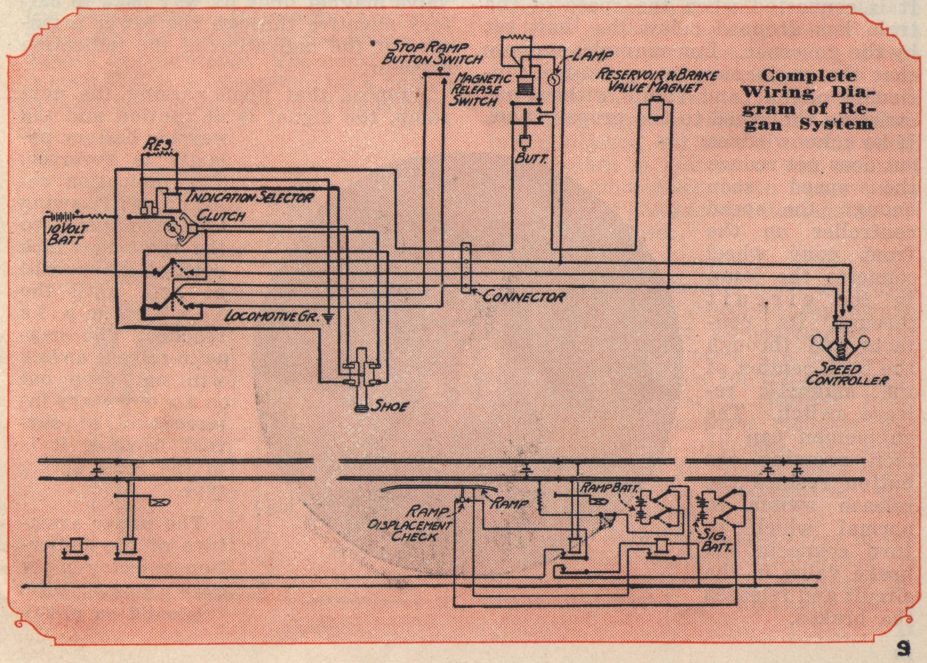
Upper Right: Shoe locked in "Off" Position for Passage through Uncontrolled Territory.

Lower Left: Shoe in Normal Position.

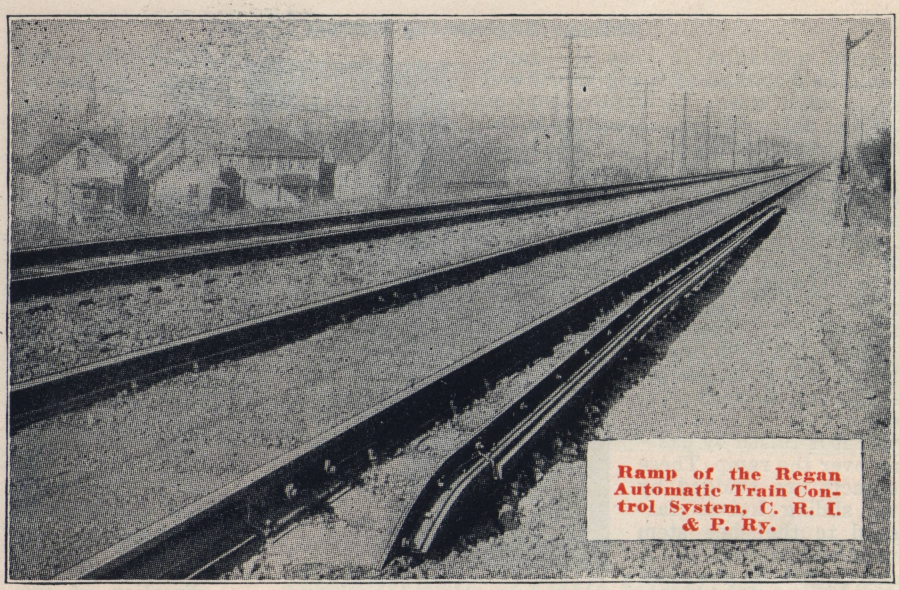
Locomotive Indication Selector

When the shoe passes over a ramp, the battery on the locomotive is cut off from the clutch, putting the armatures under control of the wayside circuit. As the locomotive passes the ramp the locomotive battery is connected to the clutch and it takes control of the selector armatures holding them in position until the next ramp is reached at which time the wayside circuit again takes control.

Note that the indication selector is capable of taking up three positions, "full proceed," "caution," and "stop," two of which are dependent on the direction of current flow from the wayside circuit. If ramp current is cut off entirely, the armatures take up the neutral position and are locked there by the lock magnet which is normally without current being connected in series with the indication selector. The resistance in parallel with the indication selector is for the purpose of limiting current through these coils.



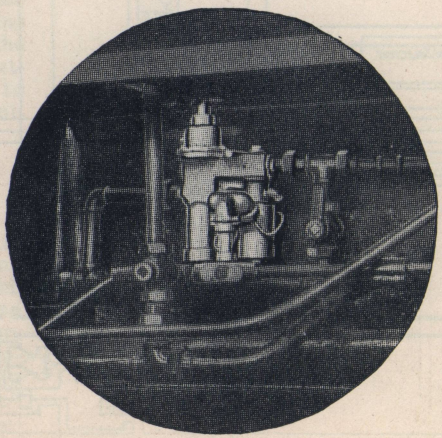
Complete Wiring Diagram of Regan System



Ramp of the Regan Automatic Train Control System, C. R. I. & P. Ry.

Speed Governor Keeps Check on Engineman

The magnetic release switch has a stick contact which controls the flow of current through the winding. The second armature controls current through the brake valve magnet. The lamp, connected to the back contact of the first armature is lighted only after a speed restriction has been imposed. It is connected when the speed of the train has dropped below the limit set by the governor. For example, suppose that the engineman has passed a cautionary signal and ramp without restricting the speed to the proper value. If he acknowledges but does not reduce the speed soon enough, the speed controller on the front pony wheel connects the lamp in the circuit through its contacts and through the back contact of the magnetic release switch. The engineman can by then pressing the button restore the release switch to normal which in turn connects the brake valve in the circuit and releases the brakes.



Electro-Pneumatic Reservoir and Brake Valve on the Regan System

All circuits are shown at normal position and at full proceed position. If you will trace the circuit from the battery to the magnetic release switch, you will see that the speed controller is not in the circuit at all. Current finds its way back from the release magnet through the upper armature of the indication selector while current which passes through the lower contact of the release switch and through the brake valve magnet finds its way back to battery negative through the lower armature of the indication of the indication selector.

Suppose that upon passing the next ramp, the signal is at caution and the wayside battery polarity is reversed. The indication selector will swing the armatures to the right in which position they will be held until the next ramp is reached. The magnetic release switch will not drop out on a momentary interruption of current because it is of the slow acting type.

The upper armature of the indication selector now connects the

(Cont'd on p. 23)

A Description of
Armorclad Switchgear

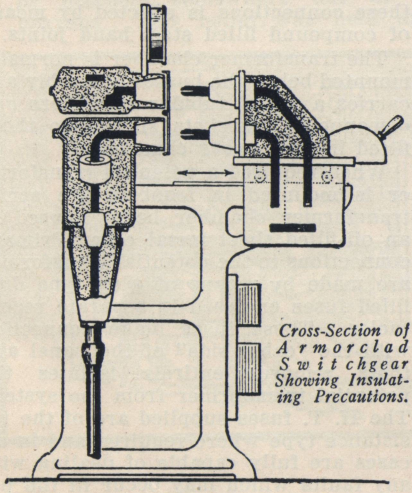
[Reyrolle Metal Covered Circuit Breakers Now Being Manufactured in America]

AFTER a most careful investigation, Allis-Chalmers Manufacturing Company is taking up the manufacture of Armorclad Switchgear. An agreemen has been made with A. Reyrolle and Company, Limited, Hebburn-on Tyne, England, who are responsible for the development and success of this type of Switchgear in Great Britain and on the Continent.

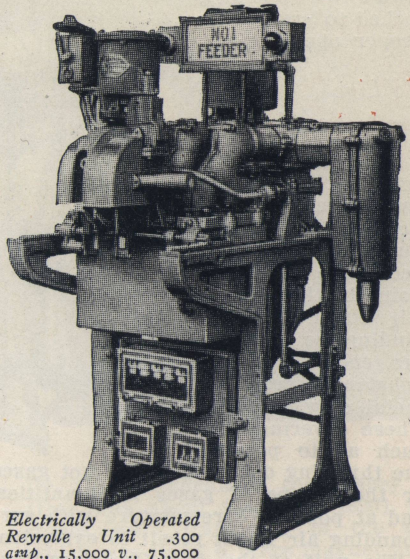
The switchgear is at the present time successfully used for volages up to 33,000 and is built in various sizes up to 1,500,000 K.V.A., breaking capacity. All conductors including bus bars, are completely enclosed in grounded metal enclosures. The conductors are first adequately insulated. When in place, the space between them and the inside walls of the metal enclosure is completely filled with solid insulating compound.

Instrument Transformers Included

Series and potential transformers and all disconnecting features are included in the metal clad switchgear. Insulated lead covered cables lead to and from compound filled dividing boxes of the switchgear. Interlocks are provided making imposisble the wrong sequence of operations. The construction is such that it is impossible for a person to make accidental contact or come within arcing distance of a live conductor.



Cross-Section of Armorclad Switchgear Showing Insulating Precautions.



Electrically Operated Reyrolle Unit .300 amp., 15,000 v., 75,000 KVA Rupturing Capacity.

In these constructions live parts are entirely protected against contact with any foreign substance, vermin, insects or animal life. The possibility of short-circuited and grounded conductors in the switchgear is reduced to an absolute minimum, but should a fault occur its duration is restricted and confined to the immediate area preventing spreading of the arc and damage to adjacent equipment.

Human Error Practically Eliminated

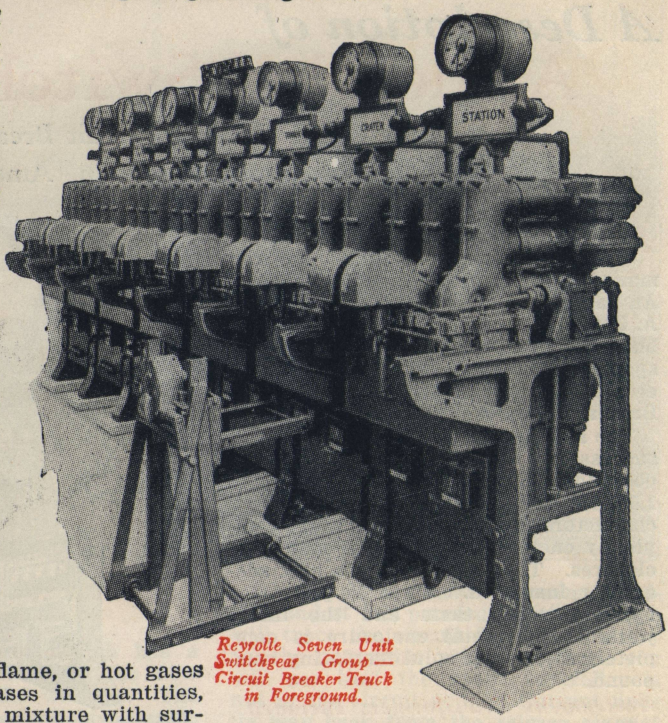
All cell construction such as transformer chambers disconnecting switch compartments and compartments for the isolation of phases are eliminated and the switch house for the completely armorclad installation resolves itself into the simplest, most compact and most inexpensive structure. Its function being solely to protect the switchgear mechanism, instruments, etc., against the elements.

The possibility of human error in the handling of Reyrolle Switchgear is practically eliminated by complete interlocking devices, so arranged that a

wrong sequence of operating may not be obtained. These interlocks are so designed and constructed that there is positively no possibility of the switchgear becoming locked to prevent its proper operation.

No Live Conductors Exposed

In a complete Reyrolle Armorclad Switchgear installation, no live conductor is exposed or accessible at any point in the station. All conductors, including the bus bars, are enclosed within substantial grounded metal coverings. These coverings are such as to prevent the throwing out of flame, or hot gases or the escape of gases in quantities, and at points where mixture with surrounding air might result in explosion.



Reyrolle Seven Unit Switchgear Group — Circuit Breaker Truck in Foreground.

The unit of the Allis-Chalmers-Reyrolle switch-gear installation is the three phase circuit breaker with mountings and all auxiliaries.

Each unit contains within itself the main oil breaker, bus bars, disconnecting devices, instrument transformers, cable pot-heads, and necessary minor features. All the live conductors involved in this assembly are either immersed in oil or solidly embedded in insulating compound and the whole are enclosed within the grounded metal casings which form the exterior covering.

Disconnection is provided by withdrawal in a horizontal direction of the carriage type oil circuit breaker, automatic locking off doors being provided to close off the orifices.

Operation of the panel is protected by positive mechanical interlocks. The component parts of each panel may conveniently be grouped for descriptive purposes under two headings:—

(a) The fixed portion which incorporates the bus-bars, instrument transformers, cable dividing boxes and supporting framework.

(b) The removable portion including the carriage type oil circuit breaker with the necessary operating mechanism.

Where duplicate bus bars are required, two similar chambers are provided for each panel these being mounted one above the other.

When two or more units are erected in line to form a continuous switchboard, inter-unit busbar connections are made by means of copper straps inter-leaved with the busbar laminations and bolted up solidly. Enclosure of these connections is effected by means of compound filled steel band joints.

The transformer chamber is normally mounted below the busbar assembly and carries a set of tubular insulators and disconnecting sockets similar to those fitted in the busbar chamber.

When required a potential transformer is mounted in front of the series transformer chamber being housed in an oil-filled sheet metal case. Primary connections to the potential transformer are made by means of plug type dust filled fuses enclosed in separate receptacles. These fuses make connection with the "cable side" of the panel and their removal entirely isolates the potential transformer from the system. The H. T. fuses supplied are of the resistance type where required and in all cases are fully capable of dealing with any faults which may occur in the potential transformer.

Dr. William Gilbert

Master of Magnetism

Chinese South Pointing Cart

IT has been claimed that the earliest known use of the magnetic needle was among the Chinese, about 2400 B. C. At times it was used to guide armies over the plains of the interior and was represented as being carried on a wagon, with the figure of a man with his extended arm pointing to the southward and known as the Chinese South Pointing Cart.

The name "magnet" is unquestionably derived from Magnesia, a city in Asia Minor although Pliny, the naturalist, derives it from Magnes, a herdsman who found himself rooted to a magnetic rock by the iron nails in his shoes and his iron staff. Magnets were made use of in the temples. A statute of Venus made from a magnet held an iron statue of Mars suspended.

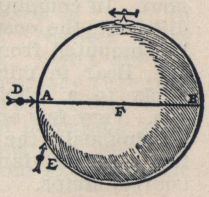
As to the force acting on the magnet to make it point north, it was thought by learned men of that time that the compass was attracted by the pole star or magnets somewhere out in the heavens. This belief was held until

Making an Artificial Magnet by Hammering Heated Steel Held in North and South Direction.

Dr. William Gilbert

Dr. Gilbert advanced the theory that (this was about the year 1600) lodestones were fragments of the earth which was itself a large magnet and to prove this theory, he constructed a miniature globe made of lodestone and showed that the compass placed at different positions acts in the same way as it does on the earth itself. This was known as Gilbert's Terrella.

Since we do not know who it was that discovered the magnet Dr. William Gilbert (1540 - 1603) must receive most credit for scientific treatment of the magnet. It was he who commenced to study the relation of the poles and it was due to his writings on this subject that further advances were made many years later.



Dr. Gilbert's Terella

He also discovered that if an iron "helmet were placed around a lodestone, it would retain its magnetism better. This amounts to the same as armature or keeper. He learned too that no substance would cut off the force of a magnet except an iron plate; that iron and steel could be magnetized from lodestone;

(Continued on page 14)

CHICAGO ENGINEERING REVIEW

Registered U. S. Patent Office

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The Low Cost of Electrical Service

PERSONS who are not familiar with the use of electrical appliances often inquire—and with a very real concern—as to the cost of operating vacuum cleaners, irons, and the many other devices that help to make the completely wired house a Home of a Hundred Comforts. It has been truly said that current is one of the cheapest things that can be bought. In proof of this assertion the following table of operating costs is offered, based on the usual rate of ten cents per kilowatt-hour. In communities where the rate is different, the cost per hour can readily be computed from the figures here given. Bear in mind that these amounts apply to a whole hour of continuous use. Very few appliances are thus used continuously, the general exceptions being electric fans, rectifiers and, of course, lamps.

	Cost of operation in Cents Per Hour
Fan (9-inch)	1/3.
Fan (12-inch)	1/2
Fan (16-inch)	4/5
Bell-ringing Transformer	1/10
Motor (⅛-H. P.)	1
Toy Transformer	1
Lamp (40-watt)	4/10
Lamp (50-watt)	5/10
Lamp (60-watt)	6/10.
Lamp (100-watt)	1
All-Nite-Lite	3/100
Vacuum Cleaner	1 3/4
Washing Machine	2 1/2
Ironing Machine (Gas Heated)	2
Chafing Dish	4
Iron (6-lb.)	5 1/2
Iron (3-lb.)	3 1/3
Hair Dryer	3/4
Radiant Heater	6
Immersion Heater	3
Coffee Percolator	5 1/2
Dishwasher	2 1/2
Toaster	5
Grill	6
Heating Pad	3/5
Utility Motor	3/4
Sewing Machine Motor	3/4
Waffle Iron	6
Shaving Mug	2 1/2
Curling Iron	1/4

Dr. William Gilbert

(Continued from page 13)

that the magnetic force moves from one end of the magnet to the other; that the lodestone attracts the purest iron best; magnetic induction by which a soft piece of iron could be made to act like a magnet although the magnetic force was not manifest with the lodestone removed; that iron could be magnetized by heating or striking it while holding it in the magnetic meridian.

From his experiments, Gilbert also learned that compound magnets are stronger than simple magnets and that placed together like a horshoe, the magnetic strength is greater. Summing up all the truths Gilbert learned about lodesones and magnets, we find that he covered the field quite well, learning not a great deal more to be learned about magnets.

Non-Metallic Cable

(Continued from page 7)

or it may be fastened to the side of the wood strip. When run parallel to a joist the cable is fastened directly to it.

In a basement, the wires may be run through the joists without a projecting strip if they are run through bored holes, oherwise the cable must be run along the surface of a wood strip in order to provide proper support.

(m) Cable in basements, if used in other than concealed work shall be run on the under side of a running board not less than ⅞ inch by 2 inches or on the side of floor joists or timbers.

It looks as though non-metallic sheath cable has come to stay because of the ease with which it can be installed. It has the disadvantage, however, that it cannot be grounded.

Editor's Note. Illustrations have been furnished through courtesy of the Rome Wire Co., Rome, New York, and the Thomas and Betts Co., New York City.

THINK!

It's a Little Word, But It Can Save a Man a Vast Amount of Grief, Says

IRA E. RICE

Member, Consultation Staff, L. L. Cooke School of Electricity

Editor's Note: Mr. Rice is an old friend to many thousands of Cooke students who have met him in the school Laboratory. His wide experience in electrical work here and elsewhere form the basis for the wonderfully helpful message he gives you in the accompanying article.

THERE was a sudden whine of protest from the motor, a sharp flash, and then the testing room was plunged into silence as the fuses blew, shutting off the machinery. The new electrician who had just connected up the motor stood by the conrol box, a dazed expression on his face.

The repair shop foreman walked over to see what was wrong.

"Don't know just how it happened, boss," the new man said in a puzzled tone. "I had her all hooked up just right, too."

"Just a minute!" cried the boss—sensing the difficulty in a glance. "You've got an A. C. repulsion motor here—don't you know this is a D. C. line? See, it tells what the motor is, right on the nameplate.

"Well, it looks just like a D. C. motor," the new man excused himelf.

"Maybe it does, but the nameplate tells you it isn't. Don't you know enough to look at the nameplate before you connect a motor?"

"Of course I do!" he replied indignantly. "I just—just didn't think."

An Excuse That Doesn't Excuse

"I just didn't think!" How many times a day is that alibi used, when some mistake is made, some foolish blunder that a man would realize perfectly well was wrong, if he'd just stop and think! It's an excuse that gives foremen and superintendents grey hairs—that has cost many a good man his job—the poorest and most damaging of all excuses.

Business has no use for the man who doesn't think. No matter how well you may know your stuff, no matter how carefully you memorize the rule book, if you don't think, you're "sunk." Any man who has studied the Chief's course knows the importance of watching the little things—like soldering and taping splices correctly, using the proper size of wire and fuses for motor circuits, testing a new installation before putting it into service, etc. But you've got to be on your toes every minute to be sure that you DO the right thing. Knowing what is right isn't enough.

In other words—you've got to THINK, every minute. Nothing takes the place of headwork. Don't assume that a thing is all right—make sure that it is. Don't run the risk of wrecking costly machinery, or of damaging your own reputation, by doing any job without thinking about it and knowing that you are correct.

The world is full of men who can follow orders blindly, who can handle a job if it is explained step by step and then somebody stands over them to make sure that they don't leave out anything. But the men who get somewhere—who are entrusted with responsibility—are the men who can do their own thinking!

Knowing the rules is important. Knowing your job is important. But the most important of all, in your fight for success, is that big little word—THINK!

Installing Electric Motors and Machinery

I—FOUNDATIONS

IN installing electric motors, the location is of first importance. It should be located so it requires a minimum of the available floor space, because in factories or industrial plants, floor space is a valuable item.

The accessibility should next be considered and the motor installed so that the bearings may be easily oiled, the commutator or slip rings easily inspected and the motor quickly and easily taken apart to renew bearings, clean the windings or replace parts. A motor which may be easily inspected and repaired, will always receive better care from the Maintenance Department, than one which is hard to get at.

This is the first article of a series describing the erecting, lining up and connecting of electric motors. Time, expense and delay may often be avoided by proper location and installation. In a great many cases, the importance of this has been overlooked making maintenance difficult.

Choosing the Foundation

After the best and most suitable location for the motor has been determined the next question is, what type of foundation must it have and how large must it be? There are no hard and fast rules governing the answering of these questions, because a great deal depends upon the size of the motor, the kind of service for which it is to be used, the type of drive, etc. The foundation of course must be strong and solid enough to prevent vibration and keep the motor level and properly lined up throughout its entire life.

If excessive vibration occurs, or the motor is not level and properly lined up, injury to the bearings or to the machine which the motor drives is bound to result and both the motor and the machine it drives are very apt to be damaged.

Very small motors need not be as carefully mounted as those of larger size but they should be rigidly fastened to their supports and if used for direct drive they must be lined up so their shafts are directly in line with the shafts of the machine they drive.

Floor Mounted Motors Should Be Elevated

It is a good plan to elevate floor mounted motors high enough to keep them out of dirt and water. Motors which are not large enough to require special foundations may be set on short pieces of plank securely fastened to the floor. The motor should be fastened to the planks with lag screws or with bolts as shown in Figure 1.

Motors mounted on concrete floors may be fastened with expansion bolts which are set in holes drilled in the concrete as in Figure 2, and located so the bolts will fit the holes in the bedplate of the motor. This is probably the easiest method and does not weaken the floor to any great extent. Another method which is often used is shown in Figure 3. Holes large enough for the foundation bolts and washers as first chipped out and the bolts and motor then put in place after which the motor is aligned and the holes filled with cement.

The above methods apply to motors of comparatively small size which do not require special bases. Larger motors should be mounted on concrete foundations.

Concrete Ratios

The concrete for a foundation usually consists of one part of cement, three parts of clean sand and six parts of crushed stone or gravel, commonly called a 1:3:6 mixture. If quick setting of the concrete is required, a 1:2:4 mixture is better.

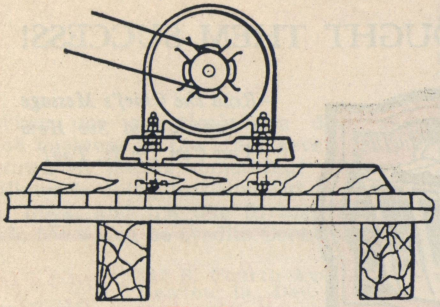


Fig. 1

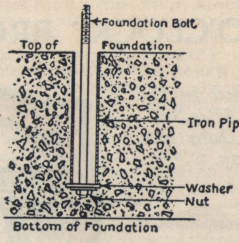
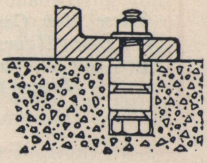


Fig. 5

Fig. 2 (Below)



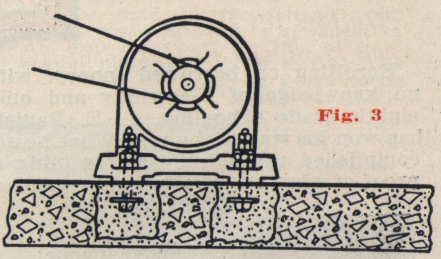


Fig. 3

No exact rules can be given for the size of foundation but usually, if the foundation extends to a good bottom and is large enough to include all of the foundation bolts, it will support the machine satisfactorily.

Manufacturers of large motors provide outline drawings showing the size and shape of the base and the location of the holes for the foundation bolts and a template should be made from the dimensions on the drawing in order to locate the foundation bolts in the proper places.

Using the Template

The template should be placed over the form in which the concrete for the foundation is to be poured and should hold the foundation bolts firmly in place while the concrete is poured around them. A nine hole template is shown in Figure 4.

In order to allow a slight variation in the position of the foundation bolts, they should be placed in iron pipes as in Figure 5. The pipes should have an inside diameter at least one inch greater than the diameter of the bolts. Large washers must be placed on the lower ends of the bolts so they cannot be pulled out of the concrete.

In Figure 6, the template is shown in place on the wooden form in which the concrete is to be poured. The pieces of pipe around each bolt are just long enough to reach the top of the concrete.

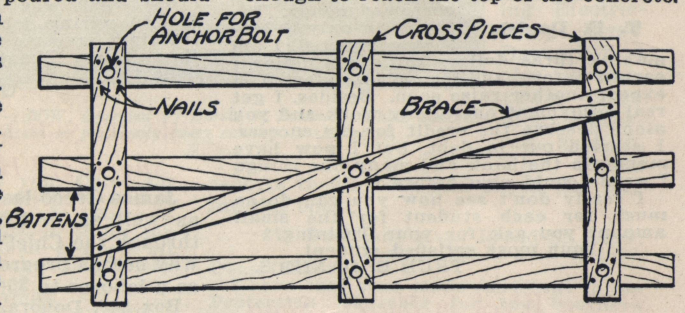


Fig. 4

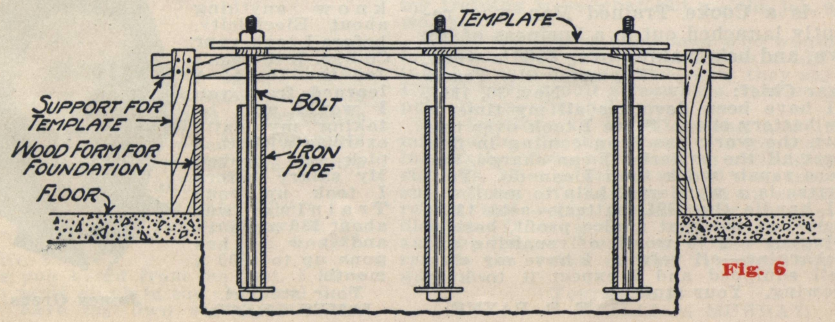


Fig. 6

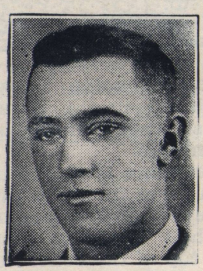
"SEVEN O'CLOCK" BROUGHT THEM SUCCESS!

These Men Cashed In On the Extra Hours After Supper, for Better Jobs and Bigger Pay

—Read the Chief's Message on Page 2 and See How You Can Do It, Too!

Now Earns Three Dollars for Every One He Used to Get

Enrolling on borrowed money, with no knowledge of Electricity and only eighth grade schooling, T. E. Daniels has won his way to the top. What he accomplished through Cooke Training is proof of what you can do if you want to.



T. E. Daniels

1454 Sherman,
Evanston, Ill.,
Dec. 2, 1927.

Dear Mr. Cooke:

When I enrolled with you I didn't know anything about Electricity. I had only an eighth grade education.

When I read your book on "The Secrets of Success in Electricity," I immediately saw my opportunity. I enrolled on borrowed money. Today, with only 36 lessons completed, I am making three dollars for every dollar I earned before, and I have just started. I expect another raise soon. Besides, I get real enjoyment out of my work and you alone deserve the credit for my success. I started out in debt, but I now have money in the bank and many fine things I never could own before.

I really don't see how you can do so much for each student for the small amount you ask for your Training.

Your most satisfied student,
TRUE E. DANIELS.

$100 a Week in Battery Shop

Things are booming in E. B. Payne's new battery shop down in Texas. "E. B." is a Cooke Trained Man who recently launched out in a business of his own, and he's making over $100 a week.

Raymondville, Texas,
Nov. 30, 1927.

Dear Chief:

I have been devoting all my time to my battery shop. Since I took over this shop the work has been coming in fine. I get all the batteries I can charge, and more repair work than I can do. Your Course is a wonderful help to me.

I handle the USL battery—sold 13 of them last week at a nice profit, besides doing over $100 worth of repairing and recharging—all velvet. I have my shop well equipped and I expect it to keep growing. Your student,

E. B. PAYNE.

Pay Goes from $3 to $9.50 a Day—Thanks to Cooke Training!

9 hours of hard work with his hands used to bring Guy Wood just $3.00. Then he learned how to work with his brain, and now he gets $9.50 for only 7 hours of pleasant, easy work.

R. No. 1, Rossman, Stottville, N. Y.
Nov. 28, 1927.

Dear Mr. Cooke:

Before I signed your enrollment I was working for a Sand company, nine hours of hard work every day for $3.00 pay. When I had completed about half your course the boss heard about it, and asked me to run one of the shovels. After one week on this job he gave me the position of overseeing all the shovels at 90% more pay.

Now I have two men under me and get $9.50 a day for 7 hours of very pleasant work. Besides, I am using my spare time to do house wiring. In 1927 I have wired 14 houses, nights after my other work was done. I now have a $175.00 wiring job ahead of me. Your training gave me more salary and spare time money. Thank you for all you have done for me.

GUY HENRY WOOD.

"Would Still Be Exercising With Shovel If I Hadn't Enrolled"

James Greco learned to write English as well as to handle electrical work, through the Chief's training. And that's why he has progressed from $20 a week as a laborer to $50 as an electrician.

Box 806, Donora, Pa. Dec. 3, 1927.

Dear Mr. Cooke:

I could not write English, nor did I know anything about Electricity before I took your Course. If it wasn't for the things I learned from you I would still be taking my daily exercise with that pick and shovel. My salary before I took up your Training was about $80 a month and now it has gone up to $200 a month.

Your student,
JAMES GRECO.

James Greco

7 Electrical Firms in City Cooke Man Gets ½ of All Work

When one electrical firm does as much business as the other seven firms in town—it means something! Henry Williams is doing just that out in Newton, Iowa, and it's due to his careful work, for which he credits Cooke Training.

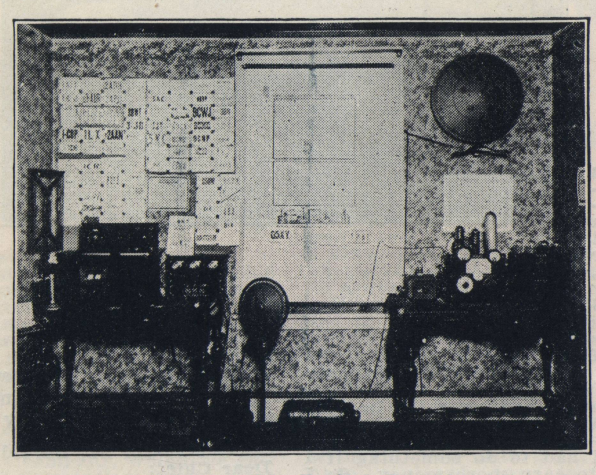
112 S. Fourth Ave., E.,
Newton, Ia., Dec. 5, 1927.

Dear Chief:

This year has been very good to me. There are seven electrical firms in this town of 12,000 population, and I started after they were all in business. I don't want to brag, but I am getting more than half the business here. I had a hard time to meet my competitors, but my work has all been first class. I haven't had a single complaint. The Electrical Inspector told the City Light Plant that my work was the best in town.

Naturally all of this has been very helpful to me, and I must say that I owe much of my success to you, Chief for your Training. I have never missed a chance to boost the school. Have a young man lined up now—I think my good luck in business had a good bit with his wanting to take the Cooke Course.

Respectfully yours,
HENRY H. WILLIAMS,
Electrical Contractor.



Station NU-2-BOW, Operated by Harold J. Brannick, which has been heard in practically every country in the world.

Has 4 Men Working for Him in Own Electrical Business

Here's another Cooke Trained Man who is going great in a business of his own. Harold Brannick is a newcomer in the field, but already the contracts are coming his way and the future seems full of opportunity.

DOBBS FERRY RADIO SHOP
Dobbs Ferry, N. Y.,
Dec. 5, 1927.

Dear Mr. Cooke:

Since you heard from me last, I have made a rapid climb in the electrical field. I now have my own store, with two salesmen and two electricians. I have been doing house wiring for only three months, but already business is so rushed we are turning work away. Just completed my eleventh housewiring job, and am figuring on six more, not to mention hundreds of smaller jobs. My lessons have saved me valuable time in making special installations. In the Radio line, I believe I do more service than any other dealer or store for miles around. I have a complete testing laboratory.

My Radio Transmitting Station, NU-2-BOW, of which I am sending you a photo, has been heard in practically every country in the world.

I will be glad to recommend your school and training to any prospective students you may have in this section. The School magazine, "The Review," is a great credit to your institution.

Respectfully,
HAROLD J. BRANNICK.

Laughed at While Studying—Gets Fine Maintenance Job

The "wisecrackers" made fun of William Murray for studying Electricity at home. But when a nice promotion came along—Murray got it. The Chief's reports to his boss had paved the way for the boost.

219 Buchanan Ave., Broad St. Park,
Trenton, N. J., Dec. 8, 1927.

Dear Chief:

I have just been made Assistant to the Protection Engineer for the Southern Division of the Public Service Electric & Gas Co., with a nice raise. This is my second raise this year. Your reports of my training were what got me the job, I was told.

There are lots of older men who would have liked this job. When I was studying they said I was crazy—now they say I must have a pull somewhere. It wasn't pull—it was "push."

My territory is 40 miles long and 10 miles wide. In that area are a generating station, two high tension switching stations, 23 substations and 10 consumer substations. We have to check up on all relays and relay installations in that district. It is a very interesting job, and the longer I work on it the more I realize the value of the Training you gave me.

Yours truly,
WILLIAM MURRAY.

Now General Foreman—Pay 4 Times as Big as Year Ago

J. M. Day was like many another who knows nothing about it—he had no faith in Home Study Training. But when he actually got started, he quickly learned that he could make real progress and earn a lot more money, through the things he studied at home.

112 Oakland Rd.,
Asheville, N. C.
Dec. 8, 1927.

Dear Mr. Cooke:

I'm sure you will be interested in learning that I am now General Foreman for this Company, and that my salary is $75 a week. This is four times as much as I was making when I enrolled for your Training, a little more than a year ago.

At that time I had no faith in Correspondence Schools—thought they were all "Cheats,"—just out for the money. But I knew I had to do something if I ever wanted to earn more money. So I took a chance with you.

In a month you had convinced me that you were on the "square." Five months later your Employment Department got me a job with the Company I am now with. Since that time I have had several promotions, and now, am General Foreman, and have under me men who have been here for years, but know nothing more about Electricity than what they had picked up as they went along.

I have surely found out that what you said was true—that a man has got to know Electricity if he wants to make big money. It was you and your Home Study Training that did it for me and I shall ever be grateful to you for it.

Your student and friend,
J. M. DAY.

Made Head Electrician—Salary Almost Doubled

It didn't take Perry Burnham long to see results on his Cooke Training. From helper he quickly rose to Head Electrician, and his salary rose right along with his knowledge.

Crichton, Ala.
Nov. 6, 1927.

Dear Mr. Cooke:

I like your Course just fine. I don't think it can be beat. I find it perfect in every way. It is the best investment I ever made.

I was Electrician helper when I began your Course. Now I am Head Electrician on the job. My salary has been almost doubled. This is what your Course did for me.

The job tickets are worth their weight in gold. I find a use for them very often.

Your best satisfied student.
PERRY A. BURNHAM.

A Cooke Student's Electrical Store

Interior of Electrical Store Owned by Student Joseph D. Campbell, 61 Rose St., Metuchen, N. J. He writes: "Although I have completed only 40 lessons, I have never been stuck on an electrical job, and I have handled some big contracts, with as high as six men working for me. I'm going to do even better from now on."

Foreman Sees Job Ticket Handbook—Gives Student Increase

The sight of an L. L. Cooke Job Ticket Handbook in his tool kit brought a $2 a day increase to Arthur Derr. And the foreman was right in giving it—for the Handbook makes a man worth more on any job!

3705-221 St., Bayside, L. I., N. Y.

Dear Chief:

I am going right ahead with my studies, taking good care to master each Work Sheet completely before I send in the answers. Now I must tell you about a peculiar thing that happened to me last week.

I was hired by one of the firms here at $6.00 per day. I worked on the job three or four days when the foreman asked me if I had a floor chisel. I told him there was one in my bag, so off he went to get it. That night I noticed somebody had been looking at my Job Ticket Handbook which I carry in my tool bag, for the rubber band was off it. I felt peeved but said nothing. With my next pay check there was a little slip:

Workman: J. A. Derr
Present Salary: $6 per day
Increase: $2 per day

Now if the foreman had not seen my Job Ticket Handbook I would never have received that raise. It showed what he thought of the little book, and believe me, I am a booster for it all the time.

Your student,
JOHN ARTHUR DERR.

Gets Free Rent and Car on New Job

His new employers are taking care of J. E. Hamil in fine style, as you can see from his letter. Jobs like his are the kind that go only to trained men.

Seminole, Okla.
Oct. 8, 1927.

Dear Friend:

I am working for the Tidal Osage Oil Co., and doing fine and dandy. I have charge of 85 75-H.P. motors. I start at $175.00 per month and house, lights, water, gas and a car furnished, and I am due for a raise soon.

So you can see what your course did for me. I have been here with them four months. I will let you know just how much a raise I get some time next month.

Yours truly,
J. E. HAMIL.

Radio Engineer Boosts Job Ticket Handbook

The more a man is "on the inside" in electrical work, the more he appreciates the value of the Chief's latest helpful feature—the Job Ticket Handbook. Roland Riley is a booster for it because he sees the real merit of it.

28 Gardiner Park, Rochester, N. Y.,
Dec. 6, 1927.

Dear Mr. Cooke:

Just received my copy of the Job Ticket Handbook today, and I must write my appreciation. It is the finest thing along this line I ever saw or heard of. Now no man who owns one can go wrong on any kind of electrical job—he has only to pull out the little book and check up on his work step by step.

I have started in the Radio business with a partner. I am the Laboratory Engineer of our company, which we call the Powerad Laboratories, Radio Specialists. We are marketing the Melo-Heald custom-built receiver under our own name. Your Course has been the making of our new business.

Ever your booster,
ROLAND T. RILEY.

Railway Signal Foreman Doubles Old Pay

Another Cooke Trained Man steps into the fascinating field of Railway Electricity—W. N. Harris of Georgia. Harris has the choice position of Signal Foreman at a good salary and he gives the Course full credit.

W. N. Harris

311 So. Troupe St., Valdosta, Ga.,
Dec. 10, 1927.

Dear Mr. Cooke:

At this holiday season, I am doubly grateful for my good fortune in taking your course. As you know I am Signal Foreman on A.G.S.R.R. and my salary is $216.52 per month, with all expenses paid. My pay is nearly double the amount I was making when I started your Course.

I very often wonder what I would be doing now if I had never found you and your course. I assure you that I never fail to recommend your school to all that I come in contact with.

Very respectfully,
W. N. HARRIS.

Operating Engineer Knocks Out Knockers

Some ill-informed people spend their time knocking anything they happen to think of—but when they knock Cooke Training they're in for a hot argument if Russell Taylor is around. Russell knows what the school has done for him and he's a booster all the time.

Russell Taylor

213 Baby St.,
Sandwich, Ont.,
Dec. 4, 1927.

Dear Sir:

I have been sending bombs to every one I ever heard knock your school and I always win my arguments. Well why shouldn't I? I have the best of material to argue about.

Chief, it was your training that put me in as Operating Engineer at $30 a month increase. I handle all the juice made at our plant as I am in charge of switchboard work.

We have two 1500 KW Synchronous converters, two 1500 KW turbo-generators and two Steam engine-generators now capable of generating 7200 KW with two new sets going in where we have replaced two triple expansion 1250 H.P. engines with synchronous motors on Generators giving us another 1500 KW in the two sets, making a total of 8700 KW and I hear rumors of another tubo-gen set going in. Of course this may sound a small amount, but when you figure in the switching connected with this work it is plenty for one operator.

Your student,
RUSSELL L. TAYLOR.

Success Sparks

Oscar Mason, Oak St., Oakland City, Ind., is "going strong" in house-wiring. He has 32 jobs ahead of him and has tripled his earnings since he took up Cooke Training.

"I've been cleaning up in Spare Time Work," writes Ralph H. Weber of Teutopolis, Ill. "$5 to $10 a day extra pay—and it sure is easy money, thanks to your Training, Chief."

The QUESTION BOX

Question:

On what principle do the new "Neon" lamps work?

Answer:

When an electric current flows through air as in an arc or lighting flash, the air, which represents the gas in a neon tube, is the conductor and gives off a characteristic color of light—violet.

Neon, which is an inert gas, also conducts current but instead of giving off a violet color, produces light which is reddish orange in color. It does not require as much pressure as a spark under ordinary air pressure, the voltage for neon lamps varying from 200 to 1,000 volts. The reason that lower voltage is needed is because of the low gas pressure inside the tube. Almost everyone is acquainted with the fact that higher voltage is required from a spark coil to produce a spark in a gas engine than in open air because of compression. Compressed air or any compressed gas for that matter is a poorer conductor than a gas that is rarified. Consequently, rarifying the neon gas makes it possible to operate the lamp at relatively low voltage.

Question:

What is meant by animal electricity?

Answer:

This is an old term no longer in use. It originated when Galvani electrified frogs' legs causing them to twitch, and later finding them to twitch without any outside application of electricity. At that time it was thought that frogs legs produced electricity, hence the term animal electricity.

Question:

What is the advantage of doughnut coils over solenoid type coils in a radio receiver?

Answer:

In the solenoid type of coil, the magnetic field reaches out into space a considerable distance whereas with the doughnut type of coil, the magnetic path is more or less confined to the inside of the coil. The doughnut coil is said to require less shielding than the Solenoid type. All coils have certain advantages and disadvantages over other types and it is a debatable question as yet which type of coil is best suited for use in radio reception.

Question:

I was told the other day that a high rate charger for storage batteries was beneficial in removing "trees." What did he mean? In my experience, I have never heard of such a thing.

Answer:

No doubt, a high charging rate will burn off trees, plates and a number of other things. Trees are small growths between the positive and negative plates caused by the battery standing idle or because of separators being too small or porous. Treeing between the plates is seldom heard of today because of experienced manufacturing.

Question:

How much resistance must be connected in series with a voltmeter having a scale reading of 15 volts to make it measure pressure up to 150 volts?

Answer:

The resistance of the multiplier will depend on the internal resistance of the voltmeter, the value of which will be found stamped inside the instrument case. For the sake of example, suppose the resistance to be 1,000 ohms: You want to operate the meter at 10 times its rated voltage, therefore, the resistance of the circuit must be 10 times as much in order to have the same current flowing through the meter coil. The total resistance must be 10 times as much or 10,000 ohms and since the resistance of the instrument is 1,000 ohms the resistance of the multiplier must be the difference or 9,000 ohms.

Instead of making this resistance yourself, it would no doubt, be just as economical to buy a multiplier from the manufacturer of the instrument, who is usually in a position to furnish a multiplier ready made for ordinary conditions such as yours.

Question:

How do you determine the time, heat and pressure for butt welding steel bars?

Answer:

No rule can be given for this. Careful experimenting is the only way to determine how to arrange the time, heat and pressure. In general, the temperature of the steel stock to be welded need be no higher than temperatures used in a blacksmith shop for welding, that is 2200° to 2400° F. The temperature must not be applied any longer than is necessary to bring the metal immediately behind the weld up to the required temperature or welding heat. The shorter the length of bar heated for the welding the better.

The pressure applied should be enough to force the two surfaces together and to slightly deform it. Then when the metal cools, the crystals of both bars form together and the well is performed.

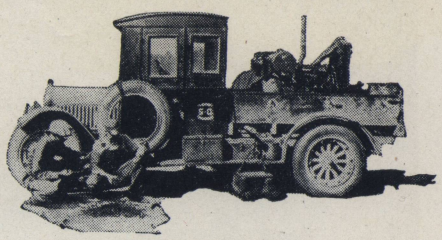
36 Pounds of Nails

Picked Up in 3-Mile Road by Magnetic Truck

SOUTH DAKOTA roads are undergoing a clean-up by means of a truck and a few magnet coils, as a result of which motorists in that state will presumably find their garage bills less tiresome.

The South Dakota State College, in collaboration with the Minneapolis service shop of the General Electric Company, recently mounted 12 magnet coils on a magnet suspended under a state highway truck. The truck was to be used for picking up nails and tacks from the highways of the state. The magnet was to be 16 inches wide by seven feet long, and the coils were to fit on a core two by seven by 14 inches. It was further desired that the coils be so constructed as to withstand moisture, inasmuch as they would occasionally be in use in wet weather.

On a 3-mile trial run, the outfit picked up 36 pounds of nails, tacks, screws, safety razor blades, fish hooks and iron particles.



The New Magnetic Truck—the Magnet Coils are Suspended in Front of the Rear Wheels

The truck travels at 10 miles an hour and covers an eight-foot strip of roadway on one trip. The magnet has a length of seven feet and also draws pieces of metal for a distance of about six inches from each end. The position of the magnet under the truck is adjustable; it is usually operated at a height of four inches above the ground. Power is supplied by a gasoline engine-driven generator mounted on the truck.

Making Vacuum Tubes

(Continued from page 4)

other words, there is less than one molecule of gas left of every seven hundred million originally present in the tube. To get full emission from the hot cathode, it is absolutely essential to have this high vacuum in the tubes.

Many special glasses have to be used in the tubes. The small ones are made from lead or lime glasses similar to those employed in incandescent lamps. X-Ray tubes are constructed either from a lime glass which contains no lead, as lead in any form dissolved in the glass absorbs X-Rays, or from a composite bulb a part of which must contain no lead, while the remainder is made from glass which contains as high as fifty per cent lead oxide. This glass, if it is more than one-quarter inch thick, prevents all X-Rays from passing through it and thus serves to protect the operator of the tube from X-Rays. The higher power radio tubes are built of a glass of low expansion and high melting point as it is less liable to crack under rapid changes of temperature and will stand higher temperatures without softening. This glass, known as G-702-P, is very similar to the well known pyrex glass, and has the added advantage that it will allow large sized tungsten wires to be sealed directly into it without the resulting seal cracking or leaking. A great amount of thought and work has been put on the glass problem to be sure that the best glass has been selected for each particular use and that it is handled in the best manner, as the success of the entire vacuum tube line depends on the reliability of the glass to metal seals and the glass bulbs.

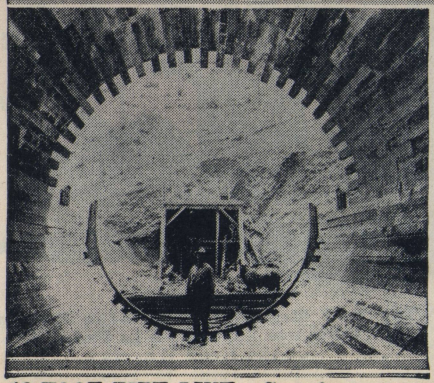
Regan Train Control

(Continued from page 10)

magnetic release switch through the medium contact of the speed controller and unless the speed of the train has been reduced below the prescribed limit this circuit will be opened causing the release switch to drop out and apply the brakes by depriving the brake magnet of current.

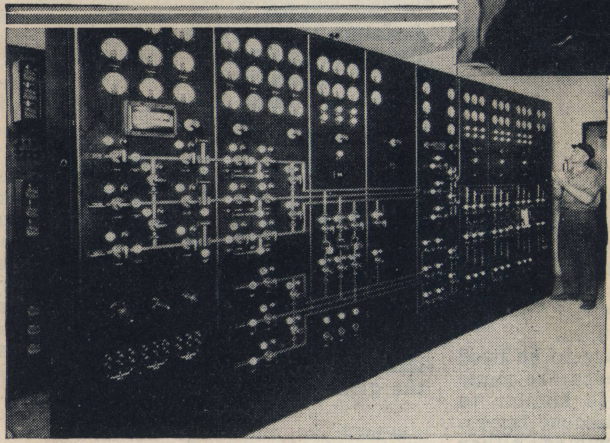
Suppose that the next ramp ahead is set at stop by reason of the signal system which opens the circuit cutting off current from the wayside battery. The indication selector drops the armatures to neutral putting the magnetic release switch in series with the low speed contact of the speed controller and unless the engineman reduces the speed of the train below the prescribed limits and brake application will follow.

WHAT'S NEW IN ELECTRICITY

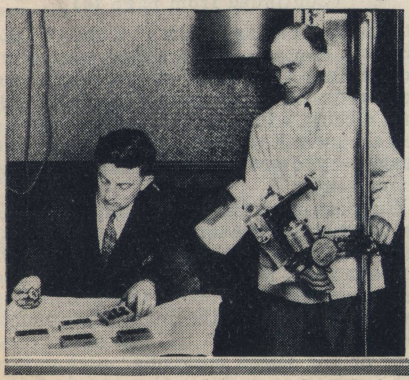


16-FOOT PIPE LINE. Crossing mountains and deserts, this continuous stave wooden pipe line several miles in length, is now under construction for a California power company. The line will divert an entire river. Note its size compared to the man.

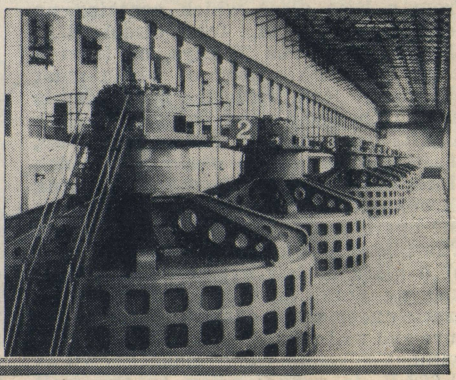
LONG RANGE "Ryan-Lite" Searchlight Gun projects pictures or messages on clouds or walls. It can be aimed like an artillery piece.



NEW YORK AUTO TUNNEL under Hudson River has millions of dollars worth of electric lights, ventilators, etc. The Switchboard shown at left is one of four controlling the vast equipment. The tunnel has just been opened.



VIOLET RAYS TRIED ON BEES. Ultra-violet treatments work favorable results in causing queen bees to lay more eggs, recent test proved. Another strange use for Electricity!



One of world's greatest hydro-electric plants is the Duke Price Power House, at Isle Maligne, Lake St. John Co., Quebec. Here are the 10 big turbines, each 30,000 KVA. Wilfred Levesque sent this picture.